Chapter 7 Homework

1. At what wavelength does the radiation peak for targets at 300 K ?

$$l = \frac{a}{T} = \frac{2.898\times10^{-3}\ (\mathrm{m\ K})}{300K} = 10\times10^{-6}\ \mathrm{m}\quad a\ =\ 2.898\times10^{-3}\ (\mathrm{m\ K})$$

or 10 microns (μ)

What is the ratio of the total power per unit area emitted by a person (300 K) and a hot vehicle (1000 K)?

Power goes as $R = s\ e\ T^4 \left(\mathrm{Watts}/\mathrm{m}^2 \right)$,

So for a black body (ε=1), the ratio is just the 4th power of the ratio of the temperatures

$$ratio = \left(\frac{300}{1000} \right)^4 = 0.00810$$

2. What are the tradeoffs between using MWIR (3-5 μm) vs LWIR (8-13 μm)
Consider the radiated energy, the detector technology (cooling issues), Rayleigh Criteria concerns.

a) radiated energy concerns depend on the temperature of the target. "Room Temperature" targets at 300 K will put out a lot more energy in the LWIR than the MWIR, so are easier to observe in that part of the spectrum. Hot missiles will put out more energy in the MWIR, and will be easier to observe there.
b) MWIR is generally a cheaper technology than LWIR, if you are comparing traditional InSb to HgCdTe detectors. This is less true with the advent of micro-bolometer arrays.
c) The Rayleigh criteria favors the MWIR by a factor of 2.

3. Of the materials in table 2, which will show the largest temperature fluctuation during a 24-hour heating/cooling cycle; which will show the smallest fluctuation? The one with the smallest fluctuation will be water, which has the largest inertia.

	Water	Sandy Soil	Basalt	Stainless Steel
K	0.0014	0.0014	0.005	0.03
Big C	1	0.24	0.2	0.12
rho	1	1.82	2.8	7.83
P	0.038	0.024	0.053	0.168
little c	1	0.131868	0.071429	0.015326
Inertia= Sqrt(K*rho*c)	0.0374	0.0183	0.0316	0.0600